

# ACTUATOR FOR A MOTOR VEHICLE TRANSMISSION

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**CROSS-REFERENCE TO RELATED APPLICATION**

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This application is a continuation of International Patent Application Serial No. PCT/DE02/00542, filed February 15, 2002, published in German, which is hereby incorporated by reference in its entirety.

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## BACKGROUND OF THE INVENTION

The invention relates to an actuator, specifically for  
the automated actuation of an automated transmission of a motor  
15 vehicle. The invention further relates to a method for  
controlling the actuator.

Actuators of this type belong to the known state of the art. In DE 19734023, for example, a shift finger in an automated transmission is actuated by two motors, one of which drives the axial movement of the shift finger and the other drives the rotation of the shift finger relative to a shaft.

While either of the motors is running, the other motor always rests. As a result, the two motors have to be relatively large, because each must be capable of delivering the required actuating force for the respective movement of the shift  
5 finger.

### OBJECT AND SUMMARY OF THE INVENTION

10 The object of the present invention is to provide an actuator, specifically for an automated transmission, that is distinguished by its simplicity and by a compact arrangement of the actuator motors, while nevertheless delivering the amounts of force required to actuate a transmission.

15 To meet the foregoing objective, the present invention proposes an actuator for the automated actuation of a transmission in the drive train of a motor vehicle. The actuator according to the invention has a central actuating  
20 shaft with a shift finger. Two grooves of opposite helical pitch are arranged on a part of the actuating shaft, and two sleeves that can be driven to rotate independently of one another are arranged essentially concentrically to the actuating shaft. Each of the two sleeves has an internal

profile, for example an inward-directed guide pin, which engages one of the grooves.

The stated objective for a transmission actuator with a central actuating shaft and a shift finger can also be attained with two sleeves arranged concentrically on the shaft, where the actuating shaft has an external profile, for example an outward-directed guide pin or preferably two outward-directed guide pins, each of which engages a helical internal groove in one of the two sleeves and where the groove in one sleeve has an opposite helical pitch from the groove in the other sleeve.

In either of the two embodiments of the foregoing description, each of the sleeves is driven by a motor, which may be an electric, hydraulic or pneumatic motor.

It is advantageous to arrange a gear mechanism between the drive motor and its respective sleeve.

It is further advantageous if the grooves in the shaft are configured with a clockwise helix pitch for one of the grooves and a counter-clockwise pitch for the other.

It is also advantageous for the two grooves to be arranged in adjacent axial sections of the shaft. According to a further exemplary embodiment, the two grooves are arranged at least in part in the same axial section of the shaft.

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#### **BRIEF DESCRIPTION OF THE DRAWINGS**

The invention will be described in greater detail, with reference to the exemplary embodiments illustrated in the drawings, wherein:

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Figure 1 represents an arrangement of an actuator,

Figure 2a represents a view of a shaft with sleeves,

Figure 2b represents a view of a shaft with sleeves,

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Figure 2c represents a cross-sectional view of a shaft with sleeves,

Figure 3 represents a cross-section of an actuator,

Figure 4 represents an arrangement of an actuator and

Figure 5 represents a cross-section of an actuator.

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#### **DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS**

Figure 1 and Figure 3 show an actuator 1 with a shaft 2 and a shift finger 3. The shift finger can be shifted in an axial direction A-A and can be rotated relative to the axis A-A. The shaft 2 is supported in the bearing 4 with rotational as well as axial mobility. To this end, a sliding sleeve 5 is arranged in a bearing seat 4, which can be permanently connected to the transmission housing. The shaft 2 is equipped at one end with an arrangement of drive motors 10, 11, which can be energized by an electronic control unit to drive the axial and rotational movements of the shaft 2 or shift finger 3.

In the embodiment of Figure 1, the drive motors 10, 11 are designed as electric motors arranged coaxially to the shaft 2, each motor being equipped with a stator 10a, 11a, and a rotor 10b, 11b. Energizing the electric motors causes the rotors 10b, 11b to rotate about the axis A. The stators 10a, 11a are connected to the motor housings 12, 13, respectively, which in turn can be mounted through a fixed connection to the transmission housing.

Each of the rotors 10b and 11b drives a sleeve 20, 21 by way of a gear mechanism 30, 31. The gear mechanism is

designed advantageously with a high reduction ratio. So-called Harmonic Drive mechanisms are well suited for this application, as are spur gear mechanisms, planetary mechanisms, or worm gear mechanisms in other embodiments. In each case the gear mechanism 30, 31 is advantageously arranged in the radial space between the rotor and the sleeve. With the independent control of the two drive motors, the sleeves 20 and 21 can be turned independently of one another. Thus they can be turned, e.g., with the same sense of rotation or with the opposite sense of rotation. The sleeves can also be driven independently at different rpm-rates.

The shaft 2 of the actuator has two grooves 40 and 41 at one end, arranged on the shaft circumference with a helical pitch, where one groove runs with a clockwise pitch and the other groove runs with a counterclockwise pitch. In the arrangement of Figure 1, the opposite helical pitches of the grooves are such that the two grooves cross each other several times. In another embodiment, the grooves may be arranged in different axial sections of the shaft so that they will not cross each other. The grooves can also be advantageously arranged such that they partially share one section of the shaft and only a part of each groove extends alone over an axial section of the shaft. The grooves are advantageously

designed with a substantially rectangular cross-section and serve as a constraining guide for elements such as pins, rollers, or fingers that engage in the grooves.

5           As an example, the sleeves 20 and 21 have inward-directed guide pins 32 and 33 which may be round or elongated in cross-section, which are constrained by the grooves so that they can only move along the grooves. It is advantageous if each sleeve 20, 21 has at least one guide pin engaged in one  
10 groove. For improved guiding properties, it may also be advantageous to use a design where two or more guide pins are engaged in each groove.

Rotating the two sleeves 20 and 21 in the same  
15 direction produces a rotation of the shaft, while rotating the sleeves in opposite directions imparts an axial movement to the shaft.

Figures 2a through 2c again show details of the shaft 2  
20 with the grooves 40, 41 and the sleeves 20, 21, in a perspective view, a side view, and a cross-sectional view, respectively.

Figures 4 and 5 show another embodiment of an actuator 100 according to the invention wherein, in contrast to the case of Figures 1 and 3, the drive motors 101, 102 are not arranged coaxially to the shaft. In this embodiment, the motors 101, 102 are positioned such that the axes of the motors are perpendicular to the axis A'-A' of the shaft 110. In another exemplary embodiment it could also be practical for the axes to be arranged parallel to the axis of the shaft 110, or at an angle that is not equal to 0 or 90 degrees. By turning or axially shifting the shaft 110, the shift finger 103 can be displaced to select a gear. The bearing 104 of the shaft 110 corresponds substantially to the bearing shown in Figure 1. The same applies to the sliding sleeve 105.

The special advantage of this arrangement is that electric motors are used to drive the sleeves by way of a worm gear mechanism with the worm gears 120, 121 and the spur gears 130, 131. Between the spur gears 130, 131 and the sleeves 140, 141, spring elements 150, 151 can be arranged in the power flow, which will permit a relative displacement of the gears relative to the sleeves against the force of the springs. The details of the sleeves and the guide pins may be taken from the description of Figures 1 and 3.



According to a further inventive concept, it can also be practical to arrange the grooves in the sleeves rather than on the shaft, in which case the guide pins would be arranged on the shaft.

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Without further analysis, the foregoing will so fully reveal the essence of the present invention that others can, by applying current knowledge, readily adapt it for various applications without omitting essential generic or specific features that set the present invention apart from the prior state of the art. Therefore, such adaptations should be understood to fall within the scope and range of equivalence of the appended claims.